

XXXV.—*Additional Notes on the Trochamminæ of the Lower Malm of the Canton Aargau, including Webbina and Hormosina.* By Dr. RUDOLF HÄUSLER, F.G.S. &c.

[Plate XV.]

IN my last paper on the *Trochamminæ* of the Lower Malm of the Canton Aargau (Switzerland) reference was made to some polythalamous species as probably belonging to *T. squamata*, *T. inflata*, *T. coronata*, *T. vesiculata*, and *T. Reussi*.

All the regularly septate rotaline Foraminifera, which in a previous memoir I described as Rotalidæ with their shells entirely changed by pseudomorphoses analogous to those which altered the chemical nature of other organic remains of this zone, have been found to be true *Trochamminæ*, since more abundant material has been obtained from the Upper Bathonian stage and almost all the various zones of the Argovian Malm.

In accordance with Brady's views on the relationship of some fixed and other free *Nodosaria*-like forms to the typical *Trochamminæ*, we unite a small number of interesting forms of *Webbina* and *Hormosina* with the genus *Trochammina* in its widest sense. However dissimilar the external appearance of these new Jurassic fossils may be when compared with the rotaline *Trochamminæ*, yet the microscopical texture of their shells gives sufficient reason for placing them in the immediate neighbourhood of the unilocular varieties of *Ammodiscus*.

We are at present not prepared to give an exhaustive treatise on all the numerous varieties, from want of sufficient material; but the most characteristic forms shall be briefly described, in order to add further proofs of the wide geological range of certain species which have hitherto been but little if at all known from the Upper Jurassic formation.

As a rule their tests are minute, thin, and very fragile; for this reason their examination presents great difficulty, especially when they are imbedded in hard marly material, from which perfect specimens are extremely difficult to extract.

The forms allied to *Hormosina* were described (*l. c.*) as silicified *Nodosariæ* and *Dentalinæ*; but there can be no doubt as to their true position among the arenaceous Foraminifera.

The fixed *Trochamminæ* (*Webbinæ*) are very feebly developed in the whole Jurassic series; and only two distinct species have been found in the zone of *Ammonites transversarius*.

Amongst the rotaline *Trochamminæ* all the species except *T. constricta* are very variable, and furnish us with new series

of intermediate forms or "missing links," by which the great number of multilocular varieties can be united in one uninterrupted chain of imperceptible gradations. Nevertheless we always come across typically built individuals, from which we are able to recognize the previously recorded species.

Beginning with the simplest septate *T. constricta*—which, with a minute variety of *T. coronata*, agrees in the composition of the delicate tests with *T. (Ammodiscus) incerta*—we arrive at the conclusion that the more the species differ from those primitive types the more the shells become proportionally coarsely sandy, finishing the series with *T. helveto-jurassica*. An analogous change distinguishes also the more complicated *Ammodisci* from the simple planispiral varieties.

It would be absolutely impossible to consider all the different varieties without taking notice of specimens from the Upper Dogger and the younger zones of the Malm, which for the present we cannot include in this short paper. Much work has still to be done to obtain a complete knowledge of the innumerable modifications as results of adaptation to considerable changes in the configuration of the sea-bottom.

The more we become acquainted with the microscopical faunas of the Jurassic formation, the more the difficulties of fixing *true species* increase; yet, on the other hand, the resemblance of many Jurassic forms to those obtained from the recent deep sea offers interesting examples of the constancy of certain types, from which countless varieties have developed themselves during enormous intervals of time.

The fact that many arenaceous Foraminifera were first described as hyaline forms altered by a replacement of the carbonate of lime by silica, can easily be accounted for by the presence of other organic remains which had undergone complete changes, as, for instance, Polyzoa, Echinoderms, and Mollusks, while the siliceous sponges were transformed into carbonate of lime or iron-pyrites.

#### A. TROCHAMMINA, J. & P.

The multilocular rotaline *Trochamminæ* belong to the whole Jurassic formation, though in the Lias and Lower Dogger they are only known in one minute form, probably an intermediate form between *T. squamata* and *T. inflata*. Like *Ammodiscus*, they first appear in greater number in the Bathonian stage, and reach their maximum development in the Lower Malm. From the zone of *Ammonites transversarius* the following species were obtained:—

<i>T. constricta</i> , Häusl.	<i>T. globigerinoides</i> , sp. nov.
<i>T. coronata</i> , Brady (var.).	<i>T. helveto-jurassica</i> , Häusl.
<i>T. squamata</i> , J. & P.	<i>T. vesiculata</i> , Uhl.
<i>T. inflata</i> , Mont.	<i>T. Reussi</i> , Uhl.

1. *Trochammmina constricta*, Häusl.

2. *Trochammmina coronata*, Brady\*.

The forms which in the first paper I mentioned as probably belonging to *T. coronata* may be a variety of this species; but the minute size of 0·3 millim. diam., and the very thin, almost hyaline test are different, while the mode of growth is nearly alike. It is very rare; and as almost all the Jurassic arenaceous varieties are much smaller than their recent representatives, they may be regarded as produced by unfavourable conditions of life.

3. *Trochammmina squamata*, J. & P.

Shell free, rotaline, composed of convolutions forming a regular conical spiral, resembling *Valvulina triangularis*. Chambers regularly increasing in size, more than three in one whorl. Upper surface conical, trochoid; inferior almost flat, concave, or slightly umbilicated. Test thin, fragile, subtransparent; cement colourless or ochreous. Surface rough. Diam. 0·4 millim.

Typical specimens are very rare in the *Amm.-transversarius* beds; they differ but little from the descriptions given by Jones and Parker, Carpenter, Karrer, &c.

4. *Trochammmina inflata*, Mont. (Pl. XV. figs. 5-7.)

Test rotaline, inflated, thin, composed of few convolutions, of which only the last is visible from the lower side. Peripheral margin rounded; umbilicus excavated. Segments large, regularly increasing in size. Earliest chambers often irregularly arranged, sometimes corroded; last chamber occasionally very large. Colour brown. Surface rough. Diam. 0·5 millim.

Many specimens agree fully with recent forms, as described by Williamson†.

The Jurassic *T. inflata* is very variable, passing from *T. squamata* into *T. globigerinoides*. The sutural lines of the oldest part are often invisible from a partial corrosion of the primary chambers.

\* Brady, "Notes on some of the Reticularian Rhizopoda of the 'Challenger' Expedition," *Micr. Journ.* vol. xix. p. 39, pl. v. fig. 15.

† Williamson, *Rec. For. Gt. Brit.* p. 50, pl. iv. figs. 93, 94.

The shells erroneously described as *Rotalina suprajurensis*, *R. macrocephala*, *R. universa*, *R. pygmæa* represent the principal Jurassic modifications.

*T. inflata* is a common species throughout the whole Malm, and it is the most abundant arenaceous form in the Bathonian zone of *Rhynchonella varians*.

5. *Trochammina globigerinoides*, sp. nov. (Pl. XV. figs. 8, 9.)

The few specimens are, as a rule, found in unfavourable preservation, owing to the minute size and thinness of the delicate shells.

Test rotaline, inflated; superior surface slightly convex, inferior excavated at the umbilicus. Convolutions few; oldest chambers small, regularly increasing in size; last four segments large, globular, of nearly equal size.

Test very thin, finely arenaceous, the hyaline sandy constituents imbedded in a subtransparent or almost glass-like colourless cement. Surface more or less rough.

*T. globigerinoides* is easily distinguished by its thin, almost hyaline test, and the globigerine mode of growth, not attempted by any other Jurassic species.

6. *Trochammina helveto-jurassica*, Häusl.  
(Pl. XV. figs. 10, 11.)

Test free, crozier-shaped, spiral only in its earlier stage, afterwards straight. Spiral part resembling *T. inflata*, composed of globular, regularly increasing chambers arranged in convolutions. Superior surface convex; first chambers often irregularly heaped or corroded; inferior umbilicated.

Rectilinear younger part consisting of few broad segments of nearly equal size.

Test finely arenaceous, cement generally subtransparent or ferruginous. Surface rough. Long. 0.6 millim.

This interesting species holds a similar position among the rotaline *Trochamminæ* as *T. centrifuga*, Brady, amongst the *Ammodisci*, *T. planorbiformis* among the *Webbince*, and *T. lituiformis* among the simpler septate *Trochamminæ*.

The species is very rare, and generally in a bad state of preservation; no aperture is visible, for this reason. Imperfect specimens with the oldest chambers removed were described as *Lituola (Haploph.) helveto-jurassica*.

7. *Trochammina vesiculata*, Uhlig\*.

This species, described by Uhlig from the same zone, is not

\* Uhlig, "D. Jurabild. v. Brünn," Beiträge z. Paläont. Oest.-Ung. vol. i. part iii. p. 181, pl. xvi. figs. 4-6, and Neues Jahrbuch f. Min. 1882, p. 155.

a rare form of the Swiss Jurassic formation. As a rule, the Argovian specimens are more convex, and the surface more rough, though in every other respect they agree fully with Uhlig's description. This variety is chiefly interesting as it is more abundant in the younger zones of the Swiss Malm. Kübler and Zwingli mention a similar form as *Rotalina badensis* from the zone of *Terebratula impressa* (Argovian II.).

#### 8. *Trochammina Reussi*, Uhlig.

The occurrence of this Upper Jurassic *Trochammina* in the Argovian deposits is still somewhat doubtful, as most of the forms resembling it can hardly be separated from the above-mentioned varieties. The specimens in my collection are, as a rule, less involute; but in all the other characteristic features they agree with Uhlig's *T. Reussi*.

### B. WEBBINA.

Although *Webbina* seems to be present in almost every Jurassic zone, beginning with the Lias, only two or three species could be discovered, of which *W. irregularis*, Orb., and a new form, *W. planorbiformis*, were found in a few specimens in the *Amm.-transversarius* beds of the canton Aargau.

#### 1. *Trochammina (Webbina) irregularis*, Orb. (Pl. XV. fig. 15.)

Test thin, fragile, finely arenaceous, one- or more-chambered; monothalamous variety consisting of a small pyriform or almost hemispherical chamber; polythalamous variety straight or irregularly curved, consisting of few small rounded segments joined by short stolons. Attached to the valves of Brachiopoda. Probably the one-chambered forms represent the earlier stage of the moniliform variety; they are very small (0.1 millim.), always elongated at one pole, thus differing from *W. hemisphaerica*, J. & P.; the surface is also rougher than in the latter species. Some of the specimens answer well the description given by D'Orbigny, Carpenter, Jones and Parker, &c.

#### 2. *Trochammina (Webbina) planorbiformis*, sp. nov. (Pl. XV. figs. 16, 16 a.)

Test serpuloid, forming in its earlier stage a regular spiral, in its younger part straight or irregularly bent. Typical specimens may be considered as fixed forms of *T. centrifuga*, Brady; the others imitate the mode of growth of some *Serpulae* found in the same zone (*S. spiroloinites*, *S. pla-*  
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*norbiformis*). Test thin, finely arenaceous, the sandy constituents imbedded in a subtransparent colourless cement. Attached to the shells of *Terebratulæ*; very rare. This species was first united with the *Nubeculariæ*; but the texture of the shell places it with the *Trochamminæ*. *W. planorbiformis* is very variable, but easily recognized from its oldest part forming a regular flat spiral. The younger part of the tube often resembles *T. filum*, Schm., and *Hyperammina*, being irregularly bent and twisted. Often two or more individuals form small colonies on the shells of Brachiopoda.

### C. HORMOSINA, Brady.

The group of straight or arcuate moniliform *Trochamminæ* is represented in the Swiss Jurassic series by several small species, none of which has, so far as I am aware, been recorded previously. While in respect of their external appearance they are isomorphs of well-known *Nodosariæ* (and *Dentalinæ*), with which I at first united them, their finely arenaceous tests place them nearest to the simple *Trochamminæ*. Besides some doubtful lageniform modifications, which are probably mere isolated segments of multilocular varieties, we possess at least three different species from the Argovian zone of *Ammonites transversarius*, of which two are preserved in several perfect specimens, while the third is never found entire, and is therefore not determinable.

The two species which I have described as *Nodosaria chrysalis* and *N. transversarii* are both good types of the genus *Hormosina*.

#### 1. *Trochammina (Hormosina) chrysalis*, Häusl.\*

The description given of this form as *N. chrysalis* applies to all the specimens I had then collected from this zone, though since several others have been discovered in various localities. It appears that *T. chrysalis* is the most constant of all the Jurassic *Trochamminæ*. As the above-cited paper is out of print, it may be useful to repeat the description.

Test straight, pupiform, composed of four or five segments, rapidly increasing in size. First chamber small, last long, almost half of the total length of the shell, slightly acuminated, bearing the small rounded aperture.

Test finely arenaceous; cement colourless or slightly ferruginous; surface smooth, resembling thus *T. incerta* of the same beds.

\* Häusler, 'Untersuchungen über die microscopischen Strukturverhältnisse der Aargauer Jurakalke,' p. 34, pl. ii. fig. 51.

In one of the specimens a broad ring was observed at the base of the last chamber. Not common.

2. *Trochammina (Hormosina) transversarii*, Häusl.\*

Test straight, elongated, slender, composed of five segments, regularly increasing in length. First segment often globular; younger chambers long, subrectangular, last pyriform.

Test thin, finely arenaceous, fragile, subtransparent; cement calcareous, colourless; surface smooth. L. 0.3 millim.

*H. transversarii* is found together with the former species, but very rare. It is variable, but easily recognizable by the thin, finely sandy, smooth test. Both *H. chrysalis* and *H. transversarii* occur also in the Upper Argovian and Lower Sequanian stages of the canton Aargau.

If we examine the long list of Upper Jurassic arenaceous Foraminifera, the large number of *Trochamminæ* is surprising; and it is doubtful if in any other period this genus reached such an extraordinary development.

Fully illustrated notes on the mutual relationship of the Jurassic *Trochamminæ*, with special regard to the numerous intermediate forms and monstrosities, will appear in a future paper during the coming winter.

*List of Trochamminæ from the Argovian zone of Ammonites transversarius.*

T. (Ammodiscus) incerta, Orb.	T. (prop.) inflata, Mont.
T. (—) gordialis, J. & P.	T. (—) globigerinoides, sp. nov.
T. (—) charoides, J. & P.	T. (—) helveto-jurassica, Häusl.
T. (—) pusilla, Gein.	T. (—) vesiculata, Uhlig.
T. (—) filum, Schm.	T. (—) Reussi, Uhlig.
T. (—) jurassica, Häusl.	T. (Webbina) irregularis, Orb.
T. (prop.) constricta, Häusl.	T. (—) planorbiformis, sp. nov.
T. (—) coronata, Brady.	T. (Hormosina) chrysalis, Häusl.
T. (—) squamata, J. & P.	T. (—) transversarii, Häusl.

*Further Notes on Trochammina (Ammodiscus) incerta.*

Since my first paper on the *Trochamminæ* of the Lower Malm appeared in this magazine careful researches in every successive layer of the zone have yielded thousands of perfect specimens, of which several not or only cursorily named in the above-cited notes deserve special mention.

By the use of new methods the most fragile forms were obtained in considerable number, while it was formerly im-

\* Häusler, *loc. cit.* p. 34, pl. ii. fig. 52.

possible to extract their perfect tests from the hard materials. One thin layer, without any traces of larger fossils, is exceptionally rich in *T. incerta*, so that on one occasion a single drop of the washing contained twenty-five specimens. In this bank the minute tests of a curious new variety are not uncommon:—

*Trochammina incerta*, var. *granulosa*, nov. (Pl. XV. fig. 1.)

Test free, discoidal, small, regularly convoluted in one plane. Convolutions numerous, partly embracing, of nearly uniform diameter; oldest convolutions covered with variously distributed minute tubercles; last convolution smooth. Aperture simple, at the non-constricted end of the chamber.

Test fine, arenaceous, transparent; cement calcareous, colourless. Surface smooth, rarely rough. Diam. 0·1 millim.

This little transparent variety is sometimes difficult to distinguish from a *Spirillina* when viewed with a low power, as the small tubercles, when arranged regularly in radial or spiral rows, give the shell the appearance of a perforated species.

*T. (Amm.) incerta*, var. *granulosa*, resembles some liassic varieties of *Involutina*\*, sometimes also *Spirillina margaritifera*†; but the shell is never biconvex as in the former, so that generally all the convolutions are visible.

*Trochammina incerta*, var. *gracilis*. (Pl. XV. fig. 3.)

*Cornuspira gracilis* and *C. media*, Kübler & Zwingli, l. c. p. 17, pl. ii. fig. 4, p. 33, pl. iv. fig. 2.

Test free, discoidal, regularly convoluted in one plane, composed of a non-septate rounded tube of almost invariable diameter. Convolutions numerous, eight to twelve; aperture simple.

Test fine, arenaceous; cement calcareous, hyaline. Surface almost smooth. Diam. 0·1 millim.

*Trochammina incerta*, var. *megaspira*, nov.  
(Pl. XV. fig. 4.)

Test free, discoidal, regularly convoluted, composed of a non-septate, generally angular tube of nearly uniform width, constricted at irregular intervals. Convolutions numerous, eight to twelve, in one plane.

Test thin, very finely arenaceous; cement calcareous, brownish. Surface smooth. Diam. 0·1 millim.

\* Mém. Acad. Imp. Metz, 1860-61, pl. vi. fig. 22; Zeitschr. deutsch. geol. Ges. 1874, pl. xviii. fig. 3.

† Williamson, Rec. For. Gt. Brit. pl. vii. fig. 204.



*Trochammina incerta*, var. *crassa*. (Pl. XV. fig. 2.)

*Cornuspira crassa*, K. & Z. *l. c.* p. 19, pl. ii. fig. 2.

Test free, discoidal, regularly convoluted in one plane. Convolutiones few, four or five, of nearly uniform width. Aperture large, simple.

Test thin; cement calcareous, colourless. Surface smooth. Diam. 0.15 millim.

The same beds C contain the compressed varieties (*Cornuspira elliptica*, and *C. concava*, K. & Z.) and a form resembling *C. oolithica*, Schm., in greatest number.

#### APPENDIX.

There remain two species of arenaceous Foraminifera, which belong probably to the genus *Trochammina*.

The first (figs. 17 and 18) consists of a simple cylindrical tube, which at its commencement forms a completely closed ring or a part of a spiral. The test is fine, arenaceous; cement calcareous, colourless. Surface smooth. L. 0.18 millim.

This peculiar form resembles *T. (Amm.) filum*, Schm., or *Uncinulina polymorpha*, Terq.

Another doubtful species (fig. 19) is free, crozier-shaped, multilocular, the septa hardly visible externally.

Test very fine, arenaceous, subtransparent; cement calcareous. Surface smooth. L. 0.2 millim.

The few small imperfect specimens are not sufficient to describe these forms exactly; but as the shell-substance resembles that of *T. (Amm.) incerta* of the same beds C, they may at present find their place among the polythalamous *Trochamminæ* nearest to *T. lituiformis*, Brady, and *T. helveto-jurassica*, Häusl.

#### EXPLANATION OF PLATE XV.

Fig. 1. *T. (Ammodiscus) incerta*, var. *granulosa*.

Fig. 2. *T. incerta*, var. *crassa*.

Fig. 3. *T. incerta*, var. *gracilis*.

Fig. 4. *T. incerta*, var. *megaspira*.

Figs. 5-7. *T. inflata*.

Figs. 8, 9. *T. globigerinoides*.

Figs. 10, 11. *T. helveto-jurassica*.

Figs. 12, 13. *T. (Hormosina) chrysalis*.

Fig. 14. *T. (Hormosina) transversarii*.

Fig. 15. *T. (Webbina) irregularis*.

Fig. 16. *T. (Webbina) planorbiformis*.

Fig. 17. } *T. (Ammodiscus)?*

Fig. 18. }

Fig. 19. *T. (Ammodiscus)?*, sp.